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BUREAU OF SUGAR EXPERIMENT STATIONS

BRISBANE

QUEENSLAND

# TECHNICAL COMMUNICATIONS.

YEAR 1953, Nos. 1 and 2

No. 1. The Diseases of Saccharum in New Guinea

by

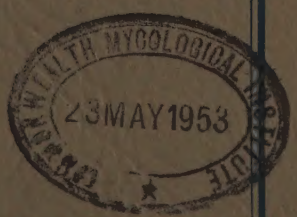
C. G. HUGHES

No. 2. Insects Associated with Sugar Cane in New Guinea

by

J. H. BUZACOTT

Issued by Direction of the Sugar Experiment Stations Board



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BUREAU OF SUGAR EXPERIMENT STATIONS

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# TECHNICAL COMMUNICATIONS.

YEAR 1953, No. 1

## The Diseases of Saccharum in New Guinea

by

C. G. HUGHES

Issued by Direction of the Sugar Experiment Stations Board

## SUMMARY

The present paper details the diseases found by the author when a member of the New Guinea cane-collecting expedition organized by this Bureau in 1951. Since the chief aim was the collection of new clones of *Saccharum*, all other activities were subordinated to it. As a result the pathological work had to be confined in most instances to field observations made during the collectings. It was not possible, for instance, to attempt isolations of possible causal agents of disease in New Guinea, and microscope work was necessarily very limited. Most of the diseases seen were easily recognized, but four at least could not be identified as known diseases. Preserved specimens of these were brought back to Brisbane, and the descriptions made should enable pathologists to recognize them if they are seen in the future.

All the available literature was examined on return from New Guinea and it was found that several new records had been made on the trip. The diseases previously recorded and seen again this time included downy mildew, eye spot, yellow spot, pokkah boeng, Fiji disease, and mosaic. New records for New Guinea were rind disease, red rot, rust, *Schizophyllum*, red rot of the leaf sheath and banded sclerotial disease. Gumming disease, which had been reported as present in New Guinea more than 50 years before but not since, was not seen by the 1951 expedition. The unknown diseases included a red-brown striping on the leaves of nobles in the highland areas, pustules on leaf blades in the coastal areas, a leaf spot probably due to a species of *Helminthosporium*, and a streaking found on one stool only near Lae.

# The Diseases of Saccharum in New Guinea

By C. G. HUGHES

## INTRODUCTION

As reported elsewhere [7], this Bureau organized a cane-collecting expedition to New Guinea in 1951 and the members taking part in it arrived in Port Moresby, the administrative capital, in the middle of April of that year. There followed a strenuous seven weeks, during which more than 1,600 miles were covered by aeroplane, jeep, boat, and on foot, with the net result that 165 varieties were despatched for planting in quarantine at Brisbane.

The two-man team engaged on the project consisted of Mr. J. H. Buzacott and the author. Mr. Buzacott had been engaged on entomological research in tropical North Queensland for a number of years before he took charge of the plant-breeding section of the Bureau. The author for a period of eleven years took an active part in the breeding work [14] and is still interested in it from the pathological viewpoint. The team was therefore well equipped in knowledge of many branches of cane culture and, besides sending back the cane varieties collected, was able to observe items of both pathological and entomological interest.

The general background and details of the itinerary as well as a list of varieties collected have already been published [7], and it is sufficient here to mention briefly the districts visited. Native gardens on the coast were inspected about Moresby and Lae and along the Markham Valley and the northern shores of the Huon Gulf in the Lae district. Foothill country to a height of between 1,000 and 2,000 feet above sea level was examined on the Laloki River near Sogeri in the Port Moresby district and on the road from Lae to Wau and Bulolo. However, the most important collections were made in the central highland area which, except for a brief and restricted visit by C. G. Lennox and C. E. Pemberton of the Experiment Station of the Hawaiian Sugar Planters' Association in 1937, had never been inspected by any sugar-cane agriculturist. This area ranged in height from 5,500 feet up to the 15,400 of Mt. Wilhelm, and cane was collected up to the limit of cane growth at nearly 8,000 feet. The localities visited included the extreme eastern edge of the high country around Aiyura and Kainantu on the upper reaches of the Ramu River, and the central and western administrative districts of Goroka and Mt. Hagen in the Purari River basin.

It must be emphasized that the party was never in one centre for more than a few days and that observations on diseases at one particular time of the year might lead to opinions differing from those formed after a period of months or years. It is well known that certain cane diseases cannot be found at all during certain seasons and that others need rather special conditions of climate or season before they develop their characteristic symptoms. It is only to be expected,

therefore, that future pathologists in the area might not only observe certain diseases not recorded by the author, but also may find other diseases more widespread than he observed to be the case. As to the question of how serious the disease problem would become if commercial cane culture were established in New Guinea, so many diverse factors, interlocking in their effects, would be involved, that even a guess in the present state of our knowledge would be presumptuous.

The 1951 Bureau expedition was first and foremost a cane-collecting trip and everything was necessarily subordinated to that aim. It was inadvisable to carry a microscope and other mycological equipment around because, apart from the risk of damage under the primitive conditions of travel, their adequate use would have demanded considerable time which was not available. The conduct of comparatively simple pathogenicity tests, for example, might have needed several months to complete. It would have been of value to have sent back to Queensland living pathological material for planting and subsequent examination—and this would have been desirable from the scientific viewpoint—but the restrictions imposed by quarantine regulations were appreciated and observed. However, a small number of preserved disease specimens were brought back.

## PREVIOUS RECORDS

The literature on the diseases of cane in New Guinea is very scattered and meagre, which is not surprising in view of the fact that of the total of nine recorded collecting trips prior to the 1951 Bureau expedition, only two included trained pathologists, although others did include someone with a practical acquaintance with cane diseases in the field. The first observations on diseases in the island were made by H. Tryon in 1895-96. He was then Entomologist to the Queensland Department of Agriculture [13], but he was much more interested in things pathological than his title would indicate, and had completed an investigation into the gumming disease of sugar cane just before he left for New Guinea. As far as is known a comprehensive report on his New Guinea trip was never made, but he did publish a description of an unidentified disease he found causing damage at Mackay in canes which had been brought from New Guinea in 1893 [27]. This disease has never been identified with any infection of recent times, and Tryon did not mention finding it in New Guinea. It is mentioned here only as a matter of historical record and pathologists interested are requested to consult the original article. Chief symptoms were a gradual but complete death of the foliage, side shooting in mature stalks, reddened vascular bundles and death of the growing point and, although transmissible by the planting of setts, it was apparently not infectious under ordinary conditions. It was described as being quite distinct from gumming, serch and rust or cane freckles.

In October, 1895, N. A. Cobb [10], who was then Pathologist to the New South Wales Department of Agriculture, published a paper on the cause of gumming in sugar cane. It followed a report [9] on diseases of cane published towards the end of 1893 by the same scientist, and concludes with the following sentence:—

> " ..... The report, in spite of its length, was reprinted extensively in official public journals as well as private periodicals devoted to the sugar

industry in all parts of the world and, as one result, it has been shown that cane in Java, New Guinea, Brazil, Mauritius, etc., etc., does either now or has in the past suffered from what is beyond reasonable doubt the same disease—gumming."

This appears to be the only positive statement that gumming disease occurred in New Guinea, and in the absence of specific references it is assumed that this is the authority for the record of the disease there by Caum [8] and Stevenson and Rands [26]. It is worth noting that Cobb himself in 1905 [11] makes no mention of New Guinea in discussing where gumming occurred.

On the other hand, H. Tryon in a report on gumming of cane [27], published in June, 1895, states that a careful inspection in December, 1894, of the New Guinea canes collected by E. Cowley in 1893 [7] and growing at the State Nursery at

FIG. 1—" Jump-up " stage of downy mildew in *robustum* cane, Central Highlands, New Guinea.

Kamerunga failed to reveal the presence of gumming disease. He had then only just completed an exhaustive enquiry into gumming disease in the Wide Bay and Burnett districts of southern Queensland, and there is no doubt that at that time he was fully cognizant of the symptoms of the disease both on the leaves and in the stem. In 1895 he made his well-known trip to New Guinea [13] and failed to see any signs of gumming in his cane-collecting forays along the southern coast of the island.

Several of the later expeditions also included men who would be expected to recognize gumming if they came across it. T. H. Wells, a cane farmer from Childers, where gumming had been very severe, made a collection in 1912 on behalf of this Bureau [7]. A. M. Carne, who collected canes in the south-eastern areas of the island in 1914, was a field officer of the Colonial Sugar Refining Company and

had served in districts where gumming was a serious problem. The 1928 expedition was led by E. W. Brandes, who before his recent retirement was head pathologist in charge of sugar plant investigations in the United States Department of Agriculture.

Since none of these observers reported the disease, and it was not seen by the members of the 1951 Bureau Expedition, and it has never been reported in quarantine plantings of canes sent from New Guinea, the conclusion is warranted that the disease is not widespread in New Guinea, and possibly does not exist there at all. Some further credence is given to this belief by the fact that many canes originally from New Guinea have proved susceptible to the disease in Queensland [15]. The varieties N.G.16, N.G.22 (Mahona), N.G.24 (Goru), 21 N.G.1, 6, 53, 82, 28 N.G.14, 18, 47, 72, 78, 96, 98, 110, 201, 262, 263, 269, 270, and 279, are included in this category either through experience in commercial plantings or from the results of Bureau resistance trials.

FIG. 2—Leaf shredding due to downy mildew in *robustum* cane, Central Highlands, New Guinea.

The 1914 expedition led by Messrs. A. M. Carne and C. Baker [7] brought back a record of Fiji and mosaic disease [23], which was confirmed later by the Brandes-Jeswiet expedition [4] [6]. In Caum's "A Contribution to a Check-List of Sugar Cane Fungi" [8] the only disease recorded for New Guinea is gumming. The ultimate source of this is probably Cobb.

The report on the international survey of the diseases of sugar cane presented to the Fourth Congress of the International Society of Sugar Cane Technologists [12] states: "New Guinea is suspected of being the home of some diseases, such as

mosaic, sereh, Fiji, leaf scald and *Sclerospora sacchari*, but there is no very definite proof." Its only definite record is of Fiji disease which was intercepted in canes from New Guinea while in varietal introduction gardens.

Lennox recorded the presence of downy mildew in New Guinea in 1937 [19] and also saw Fiji disease again. In the following year, Stevenson and Rands [26] made an addition to the diseases in New Guinea by recording the presence of yellow spot there. In 1946, R. A. Abbott [1], formerly a field officer of this Bureau, reported seeing chlorotic streak disease in one noble cane and some wild canes near Wairiki on the Gazelle Peninsula, New Britain. He had had considerable experience in North Queensland where the disease occurs, but it is at times difficult to make a positive diagnosis of chlorotic streak and it may be as well to treat this report as unconfirmed until there is more evidence available.

Martin [20] brought the list of diseases in New Guinea up to date in 1950 and, in his mention of seven diseases for the Territory, gives the new records of eye spot and pokkah boeng.

## DISEASES RECORDED

### Downy Mildew (*Sclerospora* sp.)

Although it was not until 1937 that Lennox [19] definitely recorded downy mildew in New Guinea, its presence there had been suspected for some time. In 1929, Bell [2] had the following to say:—

> " The country in which the disease ' downy mildew ' originated has not yet been determined, but it seems possible that it was introduced into Australia from Eastern New Guinea in the first collection of canes received from that area."

Some three years later, Cook [12] stated that New Guinea was suspected of being the home of, amongst other diseases, *Sclerospora sacchari*, but that there was no definite proof.

It seems probable that the place of origin of the disease will not now ever be ascertained for sure, but in the meantime there is the record that the 1951 Bureau Expedition did see downy mildew so widespread and well established in New Guinea that there is no doubt that it has been there for a very long time. The fact that some of the apparently native grasses have reached an ecological balance with the disease-causing fungus or fungi also lends support to this view.

There has been no opportunity to classify the downy mildews seen in New Guinea and, for obvious reasons, live material was not brought back, so in discussing the distribution and host range of the disease in that country, it must be borne in mind that the term " downy mildew " is used in its wider sense. It remains for the future to decide which species of *Sclerospora* are involved.

Downy mildew was not seen in the neighbourhood of Port Moresby or Sogeri on the southern coast, but was seen on the coastal country adjacent to Lae, and it occurred abundantly in the highlands.

In the Lae district, near the village of Gabsonkek, which is in the valley of the Markham River and not very much above sea level, downy mildew was found in one *robustum*-type wild cane. It occurred there chiefly in the sexual stage and the leaves of the affected plant were badly shredded. The wide floor of the Markham hereabouts is covered with a mass of wild canes in a tremendous range of clones and, although inspections could be made only on the fringe areas, downy mildew was not found and, even if not absent there, was at least not abundant. A trip up the Lae-Wau road to a point about 45 miles from Lae between the Wampit and Bupu Rivers at an elevation of 1,500 feet revealed mildew on a noble cane (51 N.G. 124) and an edible pit-pit (*S. edule*). In this area of misty rain the mildew had produced on the noble the heaviest down the author has ever seen, covering

FIG. 3—" Jump-up " downy mildew in a clump of *Miscanthus floridulus*, Central Highlands, New Guinea.

both the upper and lower surfaces of the leaves. At a lower level where the road crosses the Warrabung River at 1,000 feet, downy mildew was seen on wild canes in the river gorge.

On the highlands, mildew was seen in every district visited, *i.e.*, from Kainantu-Aiyura at the eastern edge of the plateau to Mendi beyond Mt. Hagen towards the western boundary of British New Guinea. It was particularly noticeable about Goroka, where the varieties of *robustum* used in the native " banus " or garden fence were apparently very susceptible. So much was this so that a road through gardens near the airstrip was given the name of " Downy Mildew Avenue " by the members of the expedition. Apart from the fence pit-pits, the native *Miscanthus* (*M. floridulus*) was also heavily infected and the disease was seen in a

stool of corn (*Zea mays*) and two stools of noble canes in native gardens. One diseased noble cane was 51 N.G. 22, but the stool of the other was so stunted as to be unidentifiable as to variety.

The diseased corn and chewing canes were growing in good native gardens on deep, alluvial soil, but the disease occurred on the other grasses growing under a wide range of conditions. In the Kainantu-Aiyura area mildew was very common on *Miscanthus* and was also seen on *robustum*-type canes both on hillsides amongst the *Miscanthus* and in more fertile gardens. The reed which occurs as a uniform stand in large swamps around Aiyura was apparently healthy. At Amara, mildew was not common in cane and was much less apparent in *Miscanthus* than only a few miles westward at Aiyura. The disease was found to be widespread throughout the Chimbu area in both *Miscanthus* and the pit-pit canes, but nowhere was it severe. It was not seen on any chewing cane in the area, nor was the ubiquitous garden corn affected. It was observed on the *robustum* variety 51 N.G. 91, and also on 51 N.G. 118, which is a red-leafed *Miscanthus*. Around the Mt. Hagen station, downy mildew was very common in wild canes and *Miscanthus* and was also seen in an unidentified chewing cane. The excursion to the uncontrolled Mendi area showed downy mildew very commonly in both *Miscanthus* and pit-pit canes; it was not seen in cultivated canes or corn, but only a few gardens could be inspected in the time available.

The form the disease took on the various hosts is worthy of record. In *Miscanthus* there was some mildew on both upper and lower surfaces of younger leaves, but the most noticeable feature was the shredding of the older leaves which had a yellowish-rusty appearance. It is assumed that the down seen consisted of conidiophores and conidia as in *Sclerospora sacchari*, although a microscope was not available at the time. However, the shredded leaves showed abundant oospores and measurements of them have been made in the Bureau's Brisbane laboratory. The "jump-up" stage [18] was not seen in *Miscanthus*. This grass is apparently more tolerant of cold than the pit-pit canes occurring in the highlands and it was observed on the patrol through the Chimbu district that on the higher passes the cane ceased to grow several hundred feet below the *Miscanthus*. Towards the upper limits this grass did not grow very well and the overall height of the stools including the flower head, was often only four feet or so, or less than half that at the lower levels. It was noted that while downy mildew occurred in pit-pit canes to the limit of growth, there was a marked reduction in infection in the *Miscanthus* as the variety approached its upper limit.

The pit-pit canes showed all the usual forms of downy mildew. Down was present, and could usually be found easily, at any time of the day. Shredding of the leaves was often so marked that, like some of the stools of *Miscanthus*, the infected plants had a general silky appearance as the early morning sun caught the dew on the split leaves. The "jump-up" stage was quite common. It was interesting to note that some of the banus canes were apparently resistant to the disease, *e.g.*, 51 N.G. 63, for they remained uninfected although they had obviously been growing alongside infected clones for several years. Infection was found in

the giant robustums, of which 51 N.G. 91 is one type, in several localities, indicating an unfortunate degree of susceptibility in this cane.

Very little downy mildew was seen in either noble canes or corn and the symptoms seen consisted of the conidial, down stage only. The leaf-shredding and jump-up stages were not observed although, of course, this may have been due to the time of the year. The small amount of infection in both the chewing canes and corn, even when growing in gardens showing some disease in the pit-pit fences and in the *Miscanthus* in the open country outside, may indicate that the varieties of cane and corn are resistant to the mildew present. It has been found in Australia that the grain corns in general show a degree of susceptibility much greater than cane and that there does not appear to be sufficient variation in resistance to lead one to hope that commercially resistant varieties might occur. This is, of course, an assumption necessarily hedged with restrictions, but it is perhaps not unwarranted from the experimental data available. If it can be assumed as true, then it would be expected that if the mildew were *Sclerospora sacchari*, the corn in the highlands would be heavily infected in practically every planting. The very small amount of mildew in the noble canes, since no selection of disease-free planting material is practised, might also indicate that the mildew present is not *Sclerospora sacchari*. Further indications of this are given by the facts that the asexual (conidial) and sexual stages can occur on the same plant at the same time and that conidial production is so abundant at such low temperatures.

In Queensland, the production of conidia occurs only on nights when the temperature does not fall below 65° F. and very little down forms below 70° F. Under these conditions, oospores do not form and production of conidia has usually ceased some weeks or even months before the oospores appear. From readings recorded by the Commonwealth Meteorological Bureau on the highlands it appears that conidia were produced abundantly on nights when the temperature was as low as 55° F.

**Eye Spot** (*Helminthosporium sacchari* (v. Breda de Haan) Butler)

Eye spot disease of sugar cane was reported as being present in New Guinea prior to 1951 [20], and the 1951 Bureau Expedition found it in several localities on the highlands. It was not seen in the coastal areas. It was easy to find in the gardens about Niglguma and Goromaugo, both of which are situated in deep valleys running westward to join the Chimbu River, and it was even more prevalent in the Mt. Hagen district. The symptoms, which were seen only in the chewing canes, showed characteristic spots with the normal type of runners, but there was no evidence of any spindle or growing point infection.

**Yellow Spot** (*Cercospora kopkei* Kruger)

Like eye spot disease, yellow spot had been recorded as being present in New Guinea prior to 1951 [26] and observations made by the author showed it to be fairly widespread in that island. It was seen occasionally on non-noble canes on the highlands, and on both noble and wild types at Mageri in the Port Moresby district. It was most prevalent in the high rainfall area about Lae, but even there

was not seen as a heavy infestation. It occurred on both noble and wild canes at the Warrabung River on the Lae-Wau Road at an elevation of a little over 1,000 feet above sea level and in the neighbourhood of Gabsonkek and Butibum villages on the coast near Lae.

**Rind Disease** (*Pleocyta sacchari* (Mass.) Petr. and Syd.)

Rind disease was seen on an old stalk in a stool of a noble cane at Goroka, but was not encountered anywhere else in New Guinea. *Pleocyta* is normally a very weak parasite and, unless a variety is unduly suceptible, affects only dead or near-dead cane tissue. The virtual absence of material of this type may explain why the disease was not found to be more widespread since rind disease does not normally remain confined to one locality and under commercial cropping can appear whenever conditions are suitable.

**Red Rot** (*Physalospora tucumanensis* Speg.)

The typical red discolouration with the whitish transverse areas was seen in several stools of non-noble cane in the Goroka area and, although no isolation of the causal agent was attempted, it is felt that the disease was red rot. It was not seen in stalks of noble canes but it is possible that the season was not suitable for the development of symptoms, or alternatively, since there appears to be no definite ripening period for cane on the highlands, the disease may never be obvious. The *Colletotrichum* stage of the fungus was seen on leaves of noble canes both on the highlands and on the coast near Lae. It was noted that leaves of a noble cane from near Lae taken as specimens of pustular disease (q.v. below) when dried later developed what appeared to be perithecia of *P. tucumanensis*. These showed the usual wide range of size but were appreciably smaller than those found in strains isolated in Queensland [16]. It is possible that the conditions under which the perithecia developed had an effect on their size as it certainly did on the proportion of them which did not produce spores.

**Pokkah Boeng** (*Gibberella fujikuroi* (Saw.) Wr.)

Pokkah boeng has been recorded from New Guinea before [20], and the 1951 Expedition found it in odd stools in both highland and coastal gardens. It was seen only in chewing canes and symptoms were always slight. There was no development of malformed tops and the stem infection giving rise to the " knife-cut " symptom was absent. This may have been due to the season of the year, because pokkah boeng is a seasonal disease and symptoms normally vary considerably from one part of the year to another. The fungus was seen growing in the normal position at the base of the blades on young to mature leaves, but there was only a comparatively small amount of yellow discolouration of the leaf tissue and no general collapse. The infection was never so heavy as to involve more than a leaf or two on each stalk.

**Rust** (*Puccinia kuehnii* (Kruger) Butler)

What appeared to be the true rust of sugar cane was seen on one plant of a *robustum*-type wild cane growing at Mageri. It was not seen on any other canes or in any other locality, but this single example was so typical of the disease that

there is little doubt about its identification. The lesions were found only on a limited number of leaves and did not appear to be doing any damage to the cane. This is the first record of cane rust in New Guinea.

### Schizophyllum Rot (*Schizophyllum commune* Fr.)

The characteristic fructifications of *Schizophyllum* were seen on dead cut cane at Mageri. The stalks were from a local *robustum*-type cane and there was no indication that the fungus was anything more than a saprophyte. All live stalks were free from infection. The disease was not observed elsewhere, but it must be remembered that dead stalks of banus canes were rare in any locality and dead stalks of sugar cane were never seen.

FIG. 4—Banded sclerotial disease in a Lae garden.

### Red Rot of the Leaf Sheath (*Sclerotium rolfsii* Sacc.)

Red rot of the leaf sheath was found to be fairly widespread in noble canes on the highlands. It was doing very little harm even though the practice of tightly bundling the noble canes against their supporting sticks meant that the trash remained attached indefinitely to the stalks. Even when dead the trash cannot fall away and it would be expected that under such conditions pathogens capable of growing on leaf sheaths and other leaf tissue would multiply abnormally. However, the young leaf sheaths were rarely affected and the rind against older infected sheaths did not show any lesions.

The disease was identified on a non-noble cane near Lae on the Markham Road, but was not seen elsewhere on this type of cane.

### Banded Sclerotial Disease

The causal agent of this disease of the leaf blade is variously attributed to a number of fungi and it is possible that the same effect is caused by different fungi in different countries [20]. The disease was seen in New Guinea only in a single stool of a noble cane in a garden at Bukaua near Lae (Fig. 4), where the continued high humidity from the damp situation and close proximity to the sea allowed the development of a beautiful specimen.

### Fiji Disease

The first authentic report of Fiji Disease in New Guinea appears to be that of A. M. Carne, following his cane collecting expedition with C. Baker in 1914 [23] [7]. He found it widespread in the mountainous areas inland from Buna on the southern shores of the Huon Gulf and on the Kokoda Trail from Buna overland to Port Moresby. Its wide distribution indicated that it had been in this part of New Guinea for a long time and although it occurred in Australia very much earlier than this New Guinea record [24] it does not seem probable that the disease went from Australia to New Guinea. On the other hand, movement of sugar cane from New Guinea to the mainland has probably occurred ever since island trading started and the disease could easily have come to Australia with these introductions. It actually did come with three batches of selected planting material. The first was in 28 N.G. 286 and it was found while the cane was growing in quarantine in Sydney, New South Wales [22]; the second was intercepted in the Bureau quarantine house in canes sent from the Gazelle Peninsula, New Britain, in 1946 [21], and in the third instance the disease was found in varieties sent back by the 1951 Bureau Expedition.

Brandes and Matz reported [6] that Fiji disease was found by the Brandes-Jeswiet expedition of 1928, but its occurrence was extremely rare. However, Lennox found Fiji disease throughout the territory of New Guinea both on the lowlands and on the plateau country at the head of the Ramu River watershed. The 1951 Bureau Expedition also found Fiji disease to be widespread. On the coast, it was seen in noble canes in gardens at Gabsonkek and Butibum near Lae and at Manurinumu near Sogeri, inland from Port Moresby. It was fairly general on the central highlands, although it varied considerably in amount from place to place and in the neighbourhood of Goroka could not be found at all despite a special search. The disease was most severe in the Kainantu-Aiyura district, where Lennox [19] had reported it in 1937, but heavy infection also occurred in the gardens about Ulenofi, which is on an upper tributary of the Purari River. Fiji was causing serious losses in both areas and in one particular instance a three-year old garden, approximately two acres in extent, had not yielded a single stick of sugar cane from a planting of more than 200 stools. It was found that despite the stunted growth and misshapen top the natives did not realize that there was anything wrong with Fiji diseased sticks and there was no attempt whatever to discard them when seeking plants. In an effort to prevent this loss of valuable foodstuff the Bureau is forwarding a few healthy setts each of resistant varieties to Mr. A. J. Schindler, Manager of the Highlands Agricultural Experiment Station,

with the hope that even if not actually immune these varieties may have sufficient resistance to enable a reasonable crop to be grown. Incidentally, it will be of interest to compare the reaction of these varieties to the disease at Aiyura in comparison with that obtained in Queensland under quite different conditions of growth.

While Fiji disease reached its most severe expression in the cultivated, noble canes, it also occurred in the Kainantu district in at least two clones of *S. edule*, and was found occasionally in *robustum*-type canes. In the country to the east of Aiyura towards the edge of the elevated country before it drops steeply to the Markham River valley, Fiji disease was present but did not appear to be a limiting factor in cane cultivation. It was not seen there in anything but the nobles.

A few stools affected with Fiji disease were found in various parts of the Chimbu area, when a nine-day walking patrol allowed the inspection of a large number of gardens. One diseased stool was noted in a garden near Niglguma at an elevation of over 7,000 feet, surely the greatest height above sea level at which cane disease has been recorded ! The disease was rare in canes other than nobles in the Chimbu, but was seen in a single stool of the giant robustum, 51 N.G. 91 [17], near Gondomakane.

The disease was also found in the Mt. Hagen-Mendi area, which represents the present western edge of the " controlled " area in the highlands and is just about the geographical centre of the island. As in the Chimbu, Fiji in the Hagen district was practically confined to a few stools of sugar cane in the gardens and was certainly very limited in the pit-pit types.

A general consideration of the Fiji position in the highlands leads one to several tentative conclusions regarding the disease in this part of the world. There is no general resistance of the cultivated canes in the Hagen area, for instance, in comparison with those at the eastern end for there is considerable overlapping of varieties between the two districts and the movement of varieties from one area to another is still going on. It may be, of course, that there is a rather specialized host-insect relationship involved in the ready transmission of the disease and that the necessary conditions for it are not found in all localities. In general the pit-pit canes, whether resembling the *robustum* or the *spontaneum* types, appear to be resistant judging by the low level of infection found in them. It may be that the natives, who use these canes for fences, have observed that certain (*i.e.*, diseased) canes do not grow into a dense break and so have discarded them; they do attempt some selection of pit-pit canes as evidenced by the popularity of " Gogo," the newly introduced giant robustum.

Fiji disease was not seen in *Miscanthus floridulus*, which occurs in all the highland areas, nor was it seen in any other of the large grasses there. However, a stool of *Croix lachryma-jobi* (" Job's Tears ") growing in alluvial soil on the bank of Menken Creek near the Mendi air strip showed small galls on the under-surface of the leaves and the general " bitten-off " appearance characteristic of Fiji disease in cane. Members of the genus *Saccharum* are the only recorded hosts of Fiji disease and this stool of Job's Tears was an intriguing discovery for the writer. Sections of leaf blades made in the Brisbane laboratory of the Bureau showed that

the disease was not Fiji—the characteristic proliferation of the phloem was absent—but it was suggestive of " wallaby ear," a disease presumably due to a virus found in corn in Queensland [25]. It was unfortunate that circumstances prevented a photograph being taken of this interesting plant.

## Mosaic

The first record of mosaic disease in cane in New Guinea was made by A. M. Carne [23], who found " one stool, only, of Yellow Stripe disease " during his collecting trip in 1914 [7]. He covered the hills and mountain areas to the south-east of Buna and finally came over to Port Moresby. The Brandes-Jeswiet expedition of 1928 [3] covered a much wider field, but Brandes later reported [4] that observations made at that time confirmed the extreme scarcity of mosaic in sugar cane under the natural and practically undisturbed conditions of the outlying localities visited. " Only three stools of infected cane were observed among plants in the scores of tiny, isolated native plantings examined and there were no cases in the wild species of cane, although one abundant wild species, *S. robustum*, was later proved susceptible " [4, p. 811]. Specimens of cane brought back came from a wide range of temperature and rainfall and practically all of them later developed the disease upon exposure to infection in Florida, Louisiana or Puerto Rico. Brandes stated later [5] mosaic was seen on *Croix lachryma-jobi* as well as sugar cane.

Although more recent experience has shown that the estimation of rarity of Fiji disease by the Brandes-Jeswiet expedition in 1928 did not hold when other areas in New Guinea were examined, the findings of the Bureau 1951 expedition does confirm the reported rarity of mosaic disease. It was not seen in the highlands and on the coast was found only near Lae, although a doubtful case was seen in a small grass near Rouna Falls, in the Port Moresby district. The disease at Lae was found in three shoots of a single stool of an edible pit-pit (*S. edule*) found in the village garden of Butibum. The pattern on the leaves was very marked and judging by the size of the diseased shoots could have been either from a secondary or primary infection. The stalks did not show any pattern and stools of noble canes in the garden were disease free. However, several stalks of corn were found to be infected within a few yards of the diseased *Saccharum*.

The disease at Rouna Falls was in a small unidentified grass growing naturally on rocky ground. The positive identification of mosaic in such grasses is difficult from observation alone and this report must be classified as unconfirmed.

The absence or, at least, extreme rarity of mosaic on the highlands is all the more surprising in view of the heavy population of large grasses which covers all inhabited areas. Everywhere the forest has had to retreat before the never-ending firing by the natives in their search for the small animals which form such an important source of protein. It is obvious that forests must have once extended over vast areas of the uplands and there are still extensive tracts in more favoured localities, but most of the highlands are now covered with coarse grasses, or " kunai," intermingled with clumps of various pit-pits either occurring naturally or as relics of abandoned gardens.

It has been customary to consider that, because the native inhabitants of New Guinea are still virtually stone-age people, there is little movement of persons and goods from place to place: the truth of the matter is that even before the Europeans bring peace to a district there are well-established trade channels by which a considerable movement from one part of the country to another occurs. These routes have been in existence for many years and have led to a mingling of much that is important in the lives of the natives. Sugar cane and pit-pit canes

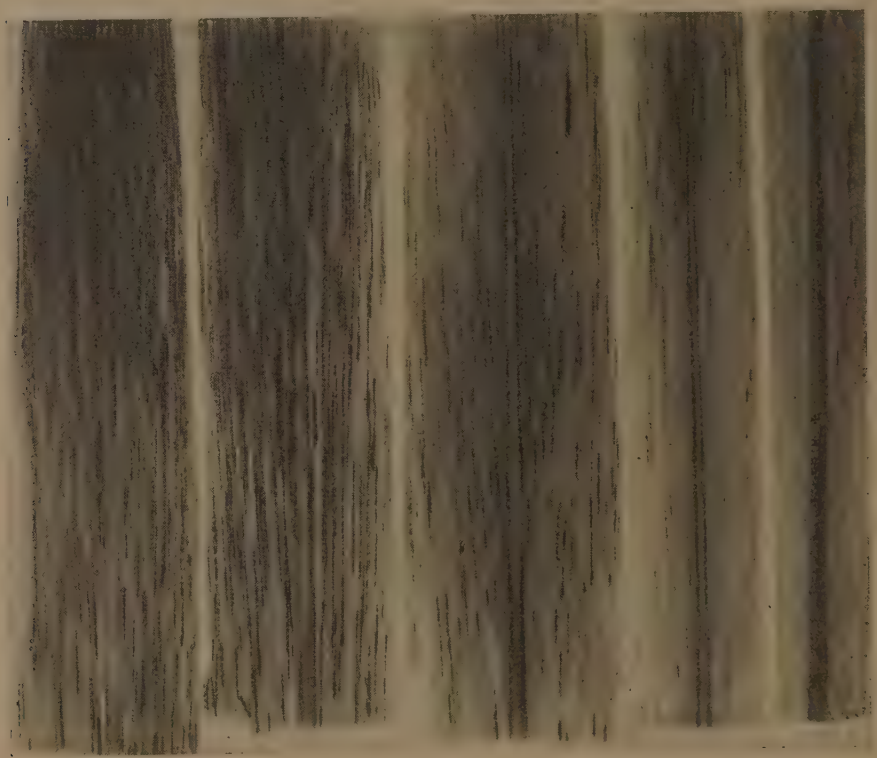

FIG. 5—The very common striping of unknown origin on noble canes, Central Highlands, New Guinea.

suitable for fences are moved as freely as any other agricultural items and the process is still continuing. The author repeatedly saw loads of cane being carried from one district to another and the current spreading of the giant robustum through the highlands also illustrates the process [7]. The lack of disease in a particular district, therefore, does lead one to conclude that the disease has not found conditions to its liking there rather than that it has never been introduced. If there is any heavy focus of mosaic, for instance, in New Guinea as there is of Fiji on the eastern end of the highlands, it seems probable that mosaic disease would have been widely distributed, although of course its development would depend on the conditions it encountered. Perhaps the comparative lack of mosaic in

New Guinea is a continuation of the trend observed on the mainland of Australia. There mosaic in cane is prevalent from the New South Wales mill areas right to Townsville at a latitude of 19°, but then becomes rare in the wet areas further north. It is not a varietal effect because tests have shown that the one variety is less susceptible in the north than in the south, and it is not due to the absence of the vector or of suitable alternate hosts. It would appear that the reason may be climatic and, as mentioned above, the effect may continue up into New Guinea.

### Unknown Diseases

There were four diseases seen on *Saccharum* in New Guinea which were unknown to the author and which to his knowledge had not been recorded in any cane-producing country. One which was widespread on the highlands produced numerous brown-red stripes on the leaves; another found on the coast and coastal foothills exhibited characteristic pustules on the leaf blade; a third was a small leaf spot due apparently to a species of *Helminthosporium*, and the fourth a streak, possibly of bacterial origin, found in a garden near Lae.

The unknown disease which was found in all highland localities visited occurred on a wide range of noble canes. It was not seen on non-nobles, and *Miscanthus* was also free from it. Its severity varied from place to place and a range of varietal susceptibility was indicated by the fact that it was not uniformly present over all varieties in individual gardens. Observations of the disease on particular varieties were not sufficiently extensive to warrant any attempt to draw up a table of resistance to it.

The typical streaks of the disease occur on the blades only of the fully expanded leaves. They are not found on the spindle leaves and there is no sign of them on the sheaths or midribs of any leaves. They first show reddish-brown lesions varying in length from a millimeter or so to eight to ten cm., with the majority of them in the range two to six cm.; the maximum width is one mm. They run with the vascular bundles and so at an acute angle to the midrib. Individual streaks have the same appearance on both leaf surfaces, and although there is a very narrow border of yellowish tissue there is no " halo " effect as seen with brown stripe disease (*Cochliobolus stenospilus* (Carp.) M. and Y.). The number of streaks varies within wide limits: in lightly affected shoots there may be only a few per leaf, in other cases the number may range from a few on the youngest leaf to so many on the older leaves that practically the whole green area is involved. Fusion of adjacent streaks frequently occurs in older leaves, especially on the upper half of the blade but, except in the senile leaves, the leaf tissue does not show any general necrosis and the striated areas of fused streaks with interspersed strips of normal green does not cause a collapse of the blade. The senile leaves show a biscuit-coloured, necrotic upper half of the blade with some shrinkage, but it was impossible to be dogmatic as to whether the disease caused a premature death of the leaves.

The general appearance of an affected shoot, the lack of lesions in the spindle and of death from the disease, as well as the fact that the disease is apparently

FIG. 6—Effects caused by low temperatures on leaves in Queensland. The patterns produced under the same set of conditions varies from variety to variety.

not transmitted by sett plantings, lead to the conclusion that the disease is not systemic. It was observed that the colour of the streaks came from discolouration of parenchyma and sheath cells and that in some streaks the sub-stomatal cavities were filled with a disorganized brown mass. These could just be seen with the naked eye as a row of dark minute dots on the surface of the leaf. In the absence of proof it is impossible to say whether these are a causal agent or are following on damage due to some other agency.

It should be pointed out that, where this disease occurred, the canes were growing at average temperatures much lower than those found in commercial sugar producing countries.

Frosts do not normally occur in these native gardens, but the average night temperatures are much below that at which cane grows and the occurrence of this disease may be bound up with these low temperatures every night throughout the entire life of the plant. There is no apparent seasonal difference in cane growth on the highlands, as indicated by the uniform length of internode in sticks which have grown for two or even three years, and, as mentioned before, it is possible the continued succession of low temperatures may have something to do with the disease.

The low temperatures and type of streak produced immediately call to mind the effects produced by low night temperatures on the leaves of cane in commercial cane areas in Queensland. When the air temperatures are not sufficiently low for complete necrosis of the green leaf tissue, unusual patterns are caused by the partial destruction of chlorophyl and the subsequent discolouration of the damaged cells. The pattern varies with the variety, ranging from the broad mosaic-like pattern found in H.Q.426 to very long narrow stripes characteristic of the comparatively frost resistant Pindar (*see* Fig. 6). Occasionally streaks are seen which bear some resemblance to those found in New Guinea (*see* Fig. 5), and it will be interesting to observe the effects of frost in Queensland on the New Guinea canes brought back here.

This leaf-streak disease is deliberately left unnamed since it is felt that until the causal agent is worked out, there is not sufficient basis for a satisfactory permanent name. A provisional name is not indicated because such a name may, like many others in the history of sugar-cane pathology, be quite unsuitable in the light of later knowledge. On the other hand, the second unknown disease mentioned in the list above has such unusual characteristic symptoms that the name " pustular disease " can be applied to it straight away. It is true that rust (*Puccinia kuehnii* (Kruger) Butl.), which incidentally was also seen in New Guinea (*see* page 9) produces pustules, but they are quite distinct from those of this new disease.

Pustular disease was seen on only three stools of cane. One was a young stool of a noble growing in a garden at Gabsonkek in the valley of the Markham River some 25 miles from Lae at an elevation of less than 100 feet above sea level. Infection on this stool was heavy and nearly all leaves showed the symptoms.

The stool was apparently growing vigorously but was too small for identification as to variety. The other infected stools were found in a garden at Manurinumu near Sogeri on the Laloki River at about 1,500 feet above sea level. One was found in the variety 51 N.G. 154 and one in 51 N.G. 164. Infection was very light in these stools and only odd pustules occurred on an occasional leaf.

The disease shows on the youngest opened leaves but not on the leaves of the spindle, which appear perfectly normal. The early symptoms consist of a yellowish green flecking. Individual spots may be up to four mm. long and to one mm. wide and they run in the general direction of the vascular bundles. They appear the same when viewed from either side of the leaf and by transmitted light

FIG. 7—Photograph from preserved specimens of "pustular" disease found on coastal New Guinea.

are very obvious as areas of lighter green merging gradually into the normal green of the blade. In the heaviest infection seen in the young leaves the spots were in a concentration up to three to four per sq. cm., but new spots appeared to develop as the leaves aged and in the old leaves covered the entire surface. The chlorotic spot stage soon develops a narrow longitudinal brown stripe with a raised beige-coloured line of necrotic tissue down the middle. The spot enlarges rapidly and as it does the epidermis is ruptured, but there is no suggestion of the dull-red spore mass found in the rusts and the central portion retains its light colour. The fully developed lesion may be up to a centimetre or more in length and more than a millimetre wide; when adjacent streaks fuse a much greater area is involved. On the old, diseased leaves which have lost or are losing their chlorophyll, the general

senile necrosis is a biscuit colour streaked longitudinally with dark red, and still showing the flaps of epidermis pushed back when the pustules erupted.

Microscopically the pustules show a stroma of tangled hyphae producing a dense mass of slender spores over the surface exposed by the rupture of the epidermis. The spores are markedly sharp at each end and are usually slightly curved. The average length of spores from dried material is of the order of 12 $\mu$.

The small leaf spot in which a *Helminthosporium* was observed occurred on a wide range of canes in all districts visited. Both noble and non-noble canes were affected and diseased stools were seen from near sea level at Lae to above 7,000 feet

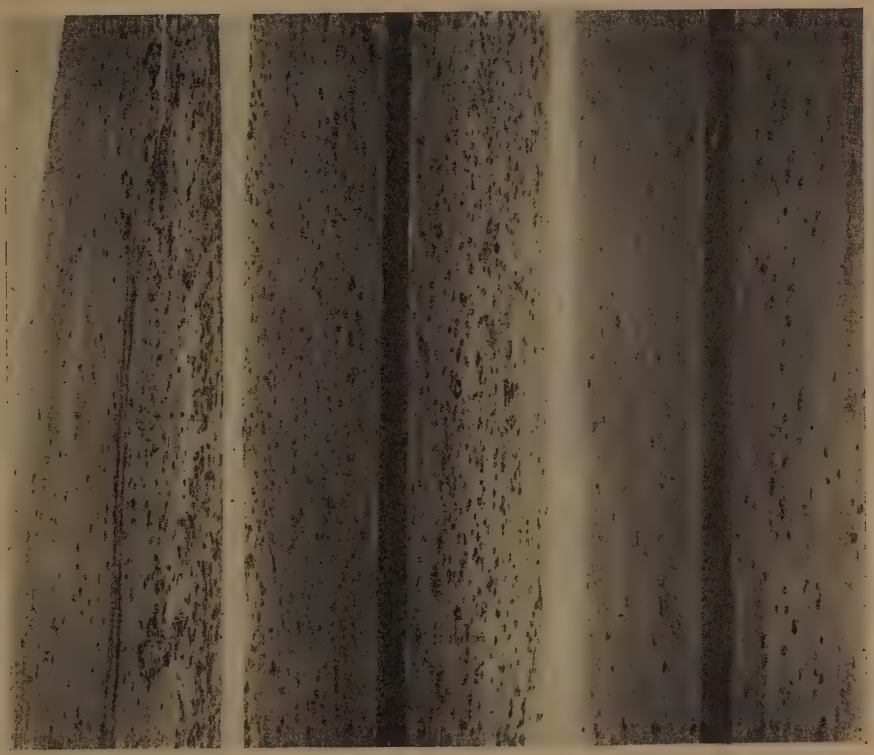

FIG. 8—*Helminthosporium* spot on leaves of noble canes.

in the Chimbu district of the central highlands. Characteristic symptoms consisted of small spots on the mature and older leaves. They were irregularly oval in outline with the long axis running in the direction of the vascular bundles and varied in number from so few that they had to be searched for to so many that the affected leaves had a general freckled appearance. The size varied from a small dot to 1.5 × 4 mm. with the majority approximately 1 × 2 mm. Fusion of adjacent spots occurred to some extent but it was not a marked feature. The very small lesions were a reddish-brown colour but all others showed a dark biscuit-coloured,

necrotic centre surrounded by a reddish-brown border. The border merged into the healthy green of the blade per medium of an inconspicuous, narrow, greenish-yellow halo. The irregularity and dark borders of the spots plus their small size were the most conspicuous features of this disease, serving to distinguish it from such diseases as ring spot (*Leptosphaeria sacchari*) and eye spot (*Helminthosporium sacchari*). Although so prevalent, the disease did not appear to be causing damage even where the spots on the leaves were numerous. There was no indication of systemic infection in any variety.

The fourth unknown disease was seen on the leaves of a small stool of an unidentified noble cane at the village of Bukaua, 30 miles from Lae along the northern shore of the Huon Gulf. Symptoms consisted of several streaks on the upper half of the fully unfolded leaves. They were up to 25 cm. long and .9 cm. wide and started and finished within the blade. Even when they extended on to the leaf edge, which was not usual, it did not assume the scorched appearance often seen in streaks due to bacterial pathogens. The streaks consisted of a pink-brown central area surrounded by a pronounced yellowish-green border gradually merging into the green of the leaf tissue. On closer examination the central part was found to consist of numerous small dots interspersed with larger necrotic areas of the same general colour. There was no evidence of streaks on the younger leaves nor was there any suggestion that there was any systemic infection.

Surface scrapings and sections of the streaks gave no indication of a pathogen being present, but some vascular bundles showed plugs which could have been caused by bacterial action. The very limited occurrence in the field and the scanty preserved material brought back meant that observations on this disease were extremely limited; it is mentioned here more as a record than as a description of a new disease.

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BUREAU OF SUGAR EXPERIMENT STATIONS

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# TECHNICAL COMMUNICATIONS.

YEAR 1953, No. 2

## Insects Associated with Sugar Cane in New Guinea

by

J. H. BUZACOTT

Issued by Direction of the Sugar Experiment Stations Board

# Insects Associated with Sugar Cane in New Guinea

By J. H. BUZACOTT.

The 1951 New Guinea Expedition undertaken by the Queensland Bureau of Sugar Experiment Stations had as its major objective the collection of clones of various species of *Saccharum*. Before joining the Plant Breeding Division of the Bureau the writer served for many years as a member of the entomological staff of this same institution. It was therefore not unnatural that during the progress of the expedition considerable interest should have been taken in the insects associated with sugar cane in the various parts of New Guinea. The time occupied in collecting, packing and despatching cane varieties allowed little opportunity for close observation of insects or for their collection and preservation. However, notes were made concerning the distribution of the common species met with and of those easily identifiable ones which were known to occur in Queensland. Species which were not familiar were collected and later despatched to the Commonwealth Institute of Entomology in London for identification.

It is interesting to note the occurrence of certain cane insects in New Guinea in relation to their distribution in other countries. Internal feeding species such as *Rhabdoscelus obscurus* would be easily transported from country to country in stalks, and therefore it is to be expected that this insect, for example, would occur also in other countries, as it certainly does. Similarly, insects which cling closely to the stem, such as *Trionymus sacchari*, are almost cosmopolitan in their distribution. On the other hand, *Perkinsiella lalokensis*, which is common in New Guinea, has apparently never been taken elsewhere. Even a country so close to New Guinea as Queensland has escaped it , although the closely related *P. saccharicida* was apparently accidentally introduced from Australia to Hawaii over a much greater distance. The white cane louse, *Oregma lanigera*, does not occur in Australia, although found through the Philippines, Formosa and Java to New Guinea. This species was first described from Java in 1897 and, in view of its wide distribution through the East, it is remarkable that it has not reached Australia.

There is as yet no indication that the cultivation of sugar cane on a commercial scale will ever be undertaken in New Guinea. If it should be, there are many insect pests present in that country which already bave a bad record themselves, or are closely related to species which seriously damage sugar cane in other countries.

In the following pages are listed the species of insects observed or collected in association with various species of *Saccharum* during the 1951 New Guinea Expedition.

## DERMAPTERA.

*FORFICULIDAE.*

*Chelisoches morio* (Fabr.).

Several species of earwig were on sugar cane in most of the areas visited. One large dark species was particularly common at Port Moresby and Sogeri and was identified as *Chelisoches morio* (Fabr.). Williams [8] states that this species is common in Hawaii, through the Malay archipelago, and on the mainland of Asia, whilst Terry [7] records it as a valuable predator of all stages of the leaf hopper, *Perkinsiella saccharicida*. Pemberton [6], however, states that it devours numbers of the leaf hopper egg parasites as well, which somewhat offsets its value.

## HEMIPTERA.

*COLOBATHRISTIDAE.*

*Phaenacantha* spp.

Two species similar to the insect known in Queensland as the " linear bug " were collected in New Guinea. One of these occurs in the lowland areas of Port Moresby and Lae and, to the writer, appeared identical with the species which infests sugar cane in Queensland, viz., *Phaenacantha australica* Kirk. In the highland districts its place is taken by a larger species which has a much darker abdomen. Although feeding in large numbers on the cane in some districts no visible damage is caused to the cane other than slight spotting of the leaves. This is not surprising since very heavy infestations of these bugs, such as sometimes occur in Queensland canefields, are not known to cause any economic damage. Neither of the two species submitted to the Commonwealth Institute of Entomology was identified beyond the genus.

*JASSIDAE.*

*Tettigella* sp. nr. *pasiphae* (Kirk.).

*Tettigella* sp.

Two species of leaf hopper which bore some resemblance respectively to the Queensland species *Cicadella spectra* Dist. and *Cicadella parthaon* (Kirk.) were observed occasionally on sugar cane in the central highlands. In one garden at Mt. Hagen a heavy infestation of these insects was seen. The specimens collected were subsequently found to belong to the genus *Tettigella*, and one was further identified as *T.* nr. *pasiphae* (Kirk.). It will be recalled that Kirkaldy [2] collected the type of *T. pasiphae* at Cairns, North Queensland.

*DELPHACIDAE.*

*Perkinsiella* sp.

Fiji disease was so common throughout the areas visited in New Guinea that considerable interest was taken in the possible insect vector of the disease there. Although several species of leaf hopper were seen feeding on sugar cane, one species was observed which strongly resembled *Perkinsiella saccharicida* Kirk., except that

it was much darker in colour. This species was very common and widespread, and like *P. saccharicida*, it has a dimorphic female. It was first seen on the tops of some recently cut sticks of *S. officinarum* which had been discarded on a rubbish dump in the residential area of Port Moresby. Not long afterwards the same species was found attacking stools of noble cane growing in a yard adjacent to the hotel at which the members of the expedition lodged whilst in Port Moresby. In this instance the insects were very numerous. During the following weeks the species was noted at Laloki River and Lae on the coast, and at Goroka, Aiyura, Mt. Hagen and several centres through the Chimbu district in the Central Highlands. It was also common at Sogeri, some 30 miles inland from Port Moresby. In addition to finding it on healthy cane it was also found on Fiji-diseased *S. officinarum* at several places, on diseased *S. robustum* at Aiyura, and on diseased *S. edule* at Chuave. The species occurred not only in the coastal areas, but also in districts over 6,000 feet above sea level. In view of its wide dispersal, its association with Fiji-diseased cane and the ability of *P. saccharicida* and *P. vastatrix* to transmit the disease [4, 5], it appears almost a foregone conclusion that this species of *Perkinsiella* is a major vector of Fiji disease in New Guinea.

Although the Commonwealth Institute of Entomology did not identify this species beyond the genus it is believed that it is *Perkinsiella lalokensis* Muir. Muir [3] collected several species of *Perkinsiella* at the Laloki River near Port Moresby in 1910. His description of these showed that only one, viz., *P. lalokensis*, has a dimorphic female and it also is a dark coloured species. Our specimens agree with Kirkaldy's description of *P. lalokensis*, so there seems little doubt regarding their identity.

The other species of *Perkinsiella* described by Muir (*loc. cit.*) from Papua, viz., *P. rattlei*, *P. bicoloris*, *P. variegata* and *P. papuensis*, may also be expected to transmit Fiji disease. *P. lalokensis* would, however, appear to be the commonest and the most widespread there, and consequently is probably the major vector. *P. saccharicida* was not seen, but Muir (*loc. cit.*) collected *P. vastatrix* Breddin, which is a known vector of Fiji disease, at the Laloki River, although it was not seen during the recent expedition.

*LOPHOPIDAE.*

*Serida* sp. n.

This Lophopid hopper was plentiful on a single stool of *Saccharum robustum* growing on the bank of a tributary of the Markham River between Lae and Wampit. The stool seemed to be stunted by insect feeding, but whether the hoppers observed there, and identified by the Commonwealth Institute of Entomology as a new species of *Serida*, were responsible for the damage it is impossible to say.

*REDUVIIDAE.*

*Pristhesancus papuensis* St.

The large predaceous bug, *Pristhesancus papuensis* St., which is common in North Queensland canefields, was several times observed on cane stools in gardens along the shores of Huon Gulf. In Queensland it preys on several species of cane pests in addition to some useful insects, such as honey bees.

*APHIDIDAE.*

*Aphis sacchari* Zehnt.

The common cane aphis, *A. sacchari*, was seen in a number of places visited, but usually only in small colonies. The one exception was in a dry river bed near Lae, where stools of *S. robustum* were heavily infested. In this instance the aphids were attended by fairly large, pale brown ants resembling *Aphaenogaster* sp.

*Oregma lanigera* Zehnt.

A most interesting observation was the occurrence of the white sugar-cane louse, or woolly aphis, *Oregma lanigera* Zehnt. This insect, which is at times a bad pest of cane in the East Indies, the Philippines and Formosa, does not occur in Queensland. In New Guinea it was seen in only a few gardens and very few varieties were badly infested. This was particularly noticeable at Kendiga, a garden in the Mt. Hagen district, where one variety, locally called " Pierrtre " (collected as 51 N.G. 117), was swarming with the aphids, although they were not to be found on any other variety in the same garden. Since the natives plant all varieties in single stools quite at random through their gardens, it would appear that most types are not attractive to the insect, and the ones upon which it mainly colonises are in some way particularly attractive to it. In this connection Yamasaki and Arikado [9] have produced evidence to show that the cell sap concentration is the factor accounting for the differences in the degrees of attraction to *O. lanigera* exhibited by different varieties in Formosa. Some large predatory larvae were seen at Kama in the Goroka district feeding on the *Oregma* colonies. They appeared to be Syrphids, but died in captivity before pupating, so no definite identification could be made.

*O. lanigera*, although not very common, was observed in widely separated localities; these included Asariufa and Kama in the Goroka district, Kendiga in the Mt. Hagen district, and Hanuabada in the Port Moresby district.

*COCCIDAE.*

*Trionymus sacchari* (Ckll.) was observed in large numbers in many parts of the coastal districts. It was also seen in the Central Highlands, but appeared to be comparatively rare there.

*ALEURODIDAE.*

*Neomaskellia bergii* (Sign.).

The common cane Aleurodid was observed in several places in the lowlands at Port Moresby, Sogeri and Lae. On one occasion it was found heavily infesting a clone of *S. robustum* on a tributary of the Markham River.

## COLEOPTERA.

*TELEPHORIDAE.*

*Chauliognathus* sp.

Among the commonest insects found on sugar cane in the Central Highlands was a soft-bodied species of beetle identified as *Chauliognathus* sp. The beetles were seen mainly in pairs, but were not observed causing any damage to the cane.

They were extremely rapid in their movements and on alighting on cane leaves rushed busily to and fro.

*Chauliognathus nigroterminalis* Lea, a species with similar habits, has been recorded in Queensland; and there are two records of very large numbers of Telephorid larvae being found in soil among cane roots. It is not known whether the larvae of the species found in New Guinea occurred in the soil at the base of the cane stools. *Chauliognathus* sp. was recorded at Goroka, Aiyura, Mt. Hagen and the Chimbu district, all of which places lie at an elevation of over 5,000 feet. Although it was not seen in the lowlands it may, of course, occur there at a different time of the year from that in which it was noticed in the highlands.

*ELATERIDAE.*

*Lacon* sp. nr. *gracilis* Cand.

Several specimens of this beetle were found in the central spindle of noble sugar canes at Gurakor, a village along the road between Lae and Wau. The principal interest of the record lies in the relationship of the species to the serious wireworm pest of sugar cane in Queensland, *Lacon variabilis* (Cand.), although it is realised that some species of this genus are purely predators. It is not known whether wireworms are ever a serious pest of sugar cane in New Guinea. The natives there plant the top of the cane only and stand it upright in the ground. It is probable that cane planted in this way germinates much more quickly than when sett-planted; in consequence the eyes may be less subject to damage from wireworms.

*MELOLONTHIDAE.*

*Dermolepida aruense* (Lansb.).

One specimen of this Melolonthid beetle was captured at light during the Expedition's sojourn at Lae. It was collected because of its resemblance to some of the Queensland species of *Lepidiota* and it was indeed interesting to have it identified as *Dermolepida aruense* (Lansb.). It thus is a close relation to the very serious *Melolonthid* pest of sugar cane in Queensland, *Dermolepida albohirtum* (Waterh.). There was nothing to indicate any connection between *D. aruense* and sugar cane, however, at Laloki River, near Port Moresby, some stools of noble canes were observed badly damaged by white grubs. The removal of a stool produced specimens of the grub responsible, which resembled the grub of *D. albohirtum* except that the setae of the raster were arranged in a different pattern. The species to which the grubs belonged is not known.

*DYNASTIDAE.*

*Scapanes australis* Boisd.

*Oryctoderus latitarsis* Boisd.

These two species also flew in to light in Lae. They were collected because of their resemblance to some of the Dynastid species recorded as damaging cane roots in Queensland. Nothing is known of their habits.

*LAMIIDAE.*

*Orinoeme* sp. nr. *lineigera* Pasc.

One of the most interesting records was that of a Longicorn beetle damaging the heart leaves of sugar cane. In the coastal villages around Lae and at Gurakor, some 1,500 feet above sea level, cane tops were frequently observed with a truncated, fan-shaped appearance which bore a slight resemblance to tops affected with Fiji disease. Closer examination showed these leaves to be perforated with fairly large holes. A search revealed the cause of the damage to be a Longicorn beetle, the nearest species to which in the British Museum is apparently *Orinoeme lineigera* Pasc. Damage from this insect was quite widespread through the whole area examined in the vicinity of Lae. In this district the native gardens are comparatively small and are surrounded by heavy rain forest. Possibly the species is a rain forest one which has turned its attention to sugar cane.

*EUMOLPIDAE.*

*Rhyparida morosa* Jac.

Of the two species of beetles seen eating the leaves of sugar cane, one was the common Queensland species, *Rhyparida morosa* Jac. The only specimens of it were recorded in the Lae district. The other species was a Hispid.

*HISPIDAE.*

*Brontispa lateralis* Uh.

The other leaf-eating beetle found on cane at Gurakor proved to be a new species of *Brontispa*, and the Commonwealth Institute of Entomology advised that it is being described by Mr. Uhmann as *Brontispa lateralis*. It was fairly common there, feeding on the cane leaves, although it was causing no appreciable damage. In Australia the only Hispid recorded as attacking sugar cane is the very small *Monochirus multispinosus* Germ.

*CURCULIONIDAE.*

*Rhabdoscelus obscurus* (Boisd.).

The well-known beetle borer of sugar cane was very rare in the Central Highlands. It was not seen at all in any garden at Goroka and was found in only one variety at Arona near Aiyura, at the source of the Markham River. It was not found in the remainder of the highland districts, but was very common on the coast, and in some gardens there it was difficult to obtain setts which were not riddled with borer tunnels. *R. obscurus* was also bad at Gurakor and Timining on the road from Lae to Wau at an elevation of some 1,500 feet. It would seem that the distribution of *R. obscurus* in New Guinea is largely a climatic one, and to this same influence might be attributed the fact that this species, whilst hitherto common in North Queensland, does not occur in the cane districts of South Queensland.

*Gloeodema spatula* Woll.

At Gurakor village another species of weevil was captured feeding on the inside of the leaf sheath of sugar cane in somewhat the same way as *Rhabdoscelus obscurus* does at times. The species was not common and only one specimen was taken.

## LEPIDOPTERA.

### *NYMPHALIDAE.*

*Melanitis leda bankia* Fabr.

This butterfly, which is very common in Queensland, Java, Mauritius and the Philippines, where the caterpillars feed on the leaves of sugar cane, was quite plentiful in the coastal districts of New Guinea.

### *NOCTUIDAE.*

*Phragmatiphila truncata* (Walk.).

Undoubtedly the most serious pest of *Saccharum officinarum* observed in New Guinea was the moth borer. It is possible that more than one species of moth borer is involved, but there was one species that was found in every cane garden visited, both in the lowland areas and the highlands. It was even seen in cane growing at an elevation of over 7,000 feet. The adults of the species were not bred out, but from long experience of the moth borer, *Phragmatiphila truncata* (Walk.), in Queensland the writer would have no hesitation in saying that the larvae seen all belonged to that species. As mentioned by Jarvis [1], this species was recorded damaging sugar cane in New South Wales by Oliff as early as 1891 under the synonym, *Nonagria exitiosa* Oliff. *P. truncata* is held in reasonably good control in Queensland by a complex of parasites and predators, but in New Guinea does not appear to be under effective control. In Queensland it tends at times to cause bad damage to cane growing close to very grassy headlands. The mixed cultivation which is carried out in most New Guinea native gardens may tend to favour the pest.

In some of the villages visited the larvae of the moth borer were cut out and eaten as a delicacy by the natives, but this practice was by no means common.

### *COSMOPTERYGIDAE.*

*Cosmopteryx* sp.

The tunnelling of a midrib borer in cane leaves was commonly observed in both high and lowland districts. The damage appeared identical with that caused in Queensland by *Cosmopteryx dulcivora* Meyr. There are a number of species of *Cosmopteryx* recorded through the Austro-Malayan region as attacking cane leaves, and no doubt one or other of these was involved.

## ACARIDAE.

In many of the sugar-cane varieties seen, mite damage in the bud grooves of the stem was very severe. No specimens of the mites were seen, but the damage was similar to that referred to by Williams [8] as caused by the stalk mite, *Tarsonemus spinipes* Hirst., in Hawaii. Whether this species was the one involved or not, the damage was widespread, particularly through the highland areas visited, and some varieties appeared to be very highly susceptible to the mite. The worst damage of all was recorded at Kuminakira in the Aiyura district.

## ACKNOWLEDGMENT.

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